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(71) Applicant(s)
Telefonaktiebolaget L M Ericsson (publ)
(Incorporated in Sweden)
SE-126 25 Stockholm, Sweden

(72) Inventor(s)
Peter Hans Edlund

(74) Agent and/or Address for Service
Haseltine Lake & Co
Imperial House, 15-19 Kingsway, LONDON,
WC2B 6UD, United Kingdom

(54) Abstract Title
SGSN handover in a GPRS Network

(57) A Serving GPRS Support Node (SGSN) handover procedure, for use in a GPRS network, reduces the need for resequencing in the SGSN. This is achieved in that the old SGSN sends a message to the Gateway GPRS Support Node (GGSN), requesting that it stop transmission of data. At that time, the old SGSN transfers to the new SGSN any data which it needs to transmit to the mobile station. The GGSN resumes transmission of data, this time to the new SGSN, when the handover is complete. This reduces the requirement for the new SGSN to resequence the received data. The signal from the old SGSN to the GGSN, requesting it to stop transmission, can be initiated when the old SGSN receives a message from the new SGSN, informing it that the mobile station has moved to a cell served by the new SGSN. Alternatively, the signal can be sent from the old SGSN to the GGSN, on receipt by the old SGSN of a message from the serving base station, informing it that the mobile station has changed to a cell served by another SGSN.

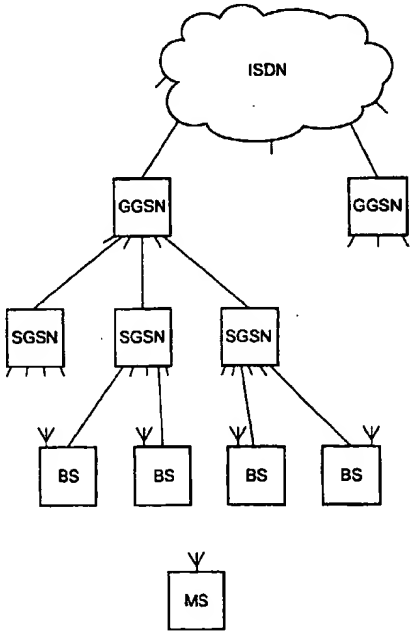

Fig. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

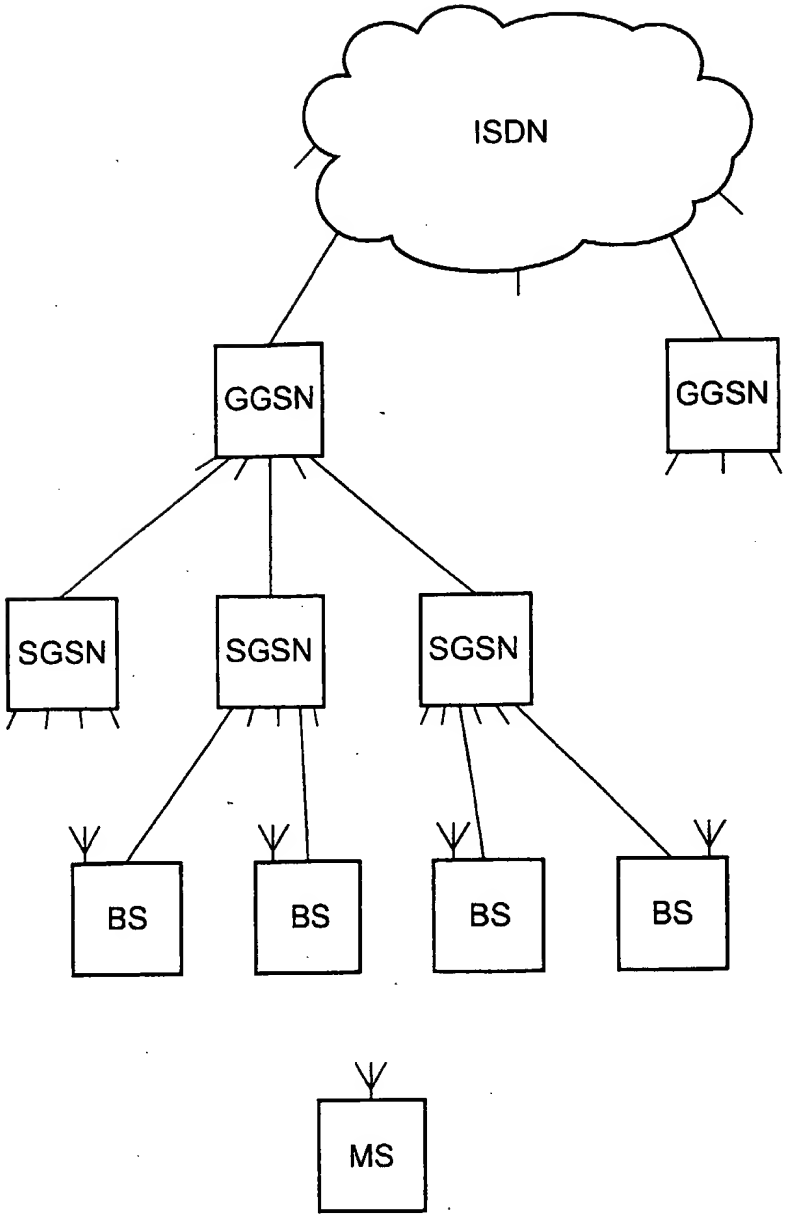

Fig. 1

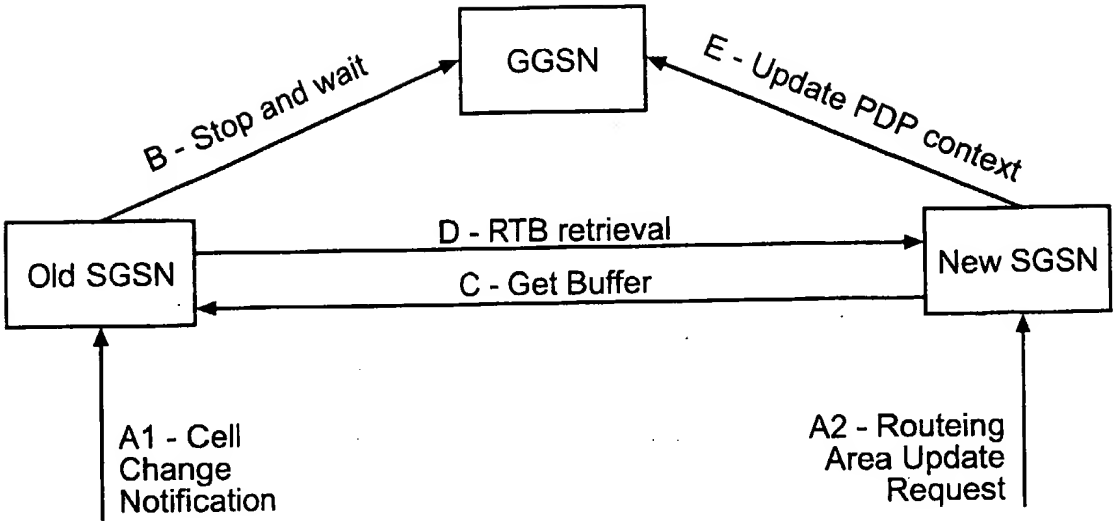
GGSN
B - Stop and wait
E - Update PDP context
Old SGSN
D - RTB retrieval
C - Get Buffer
New SGSN
A1 - Cell Change Notification
A2 - Routeing Area Update Request

Fig. 2

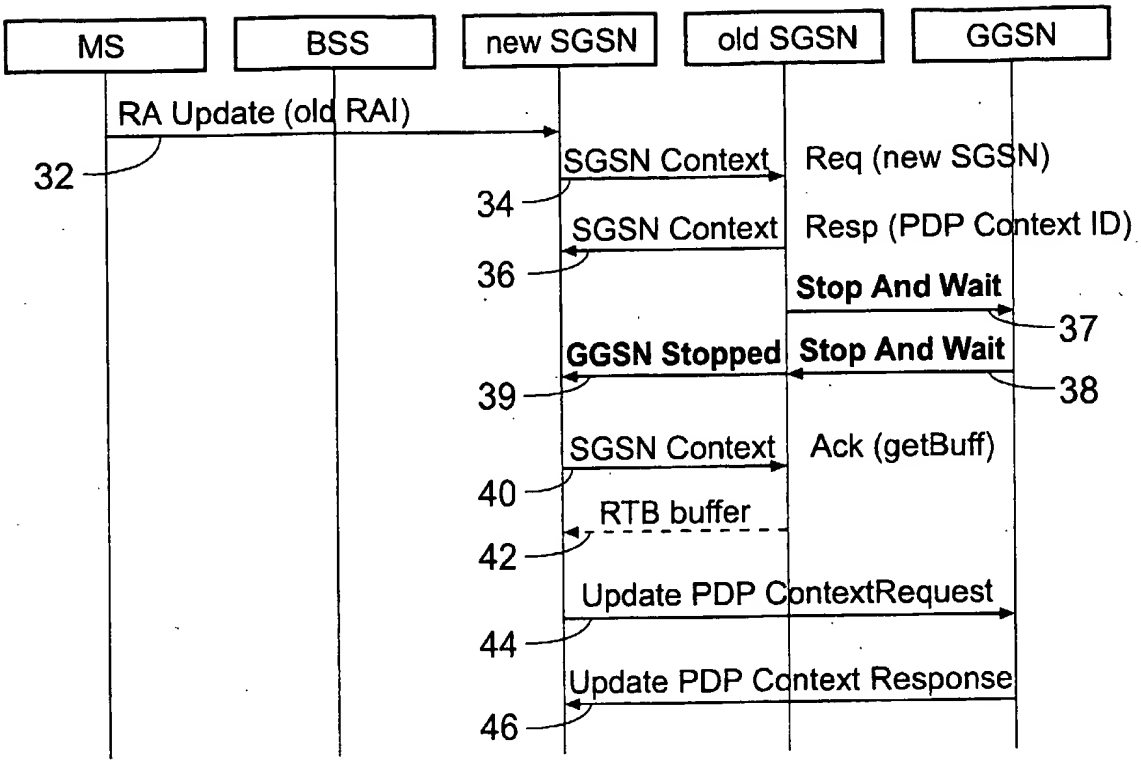
MS
BSS
new SGSN
old SGSN
GGSN
RA Update (old RAI)
32
SGSN Context
Req (new SGSN)
34
SGSN Context
Resp (PDP Context ID)
36
Stop And Wait
37
GGSN Stopped
Stop And Wait
39
38
SGSN Context
Ack (getBuff)
40
RTB buffer
42
Update PDP ContextRequest
44
Update PDP Context Response
46

Fig. 3

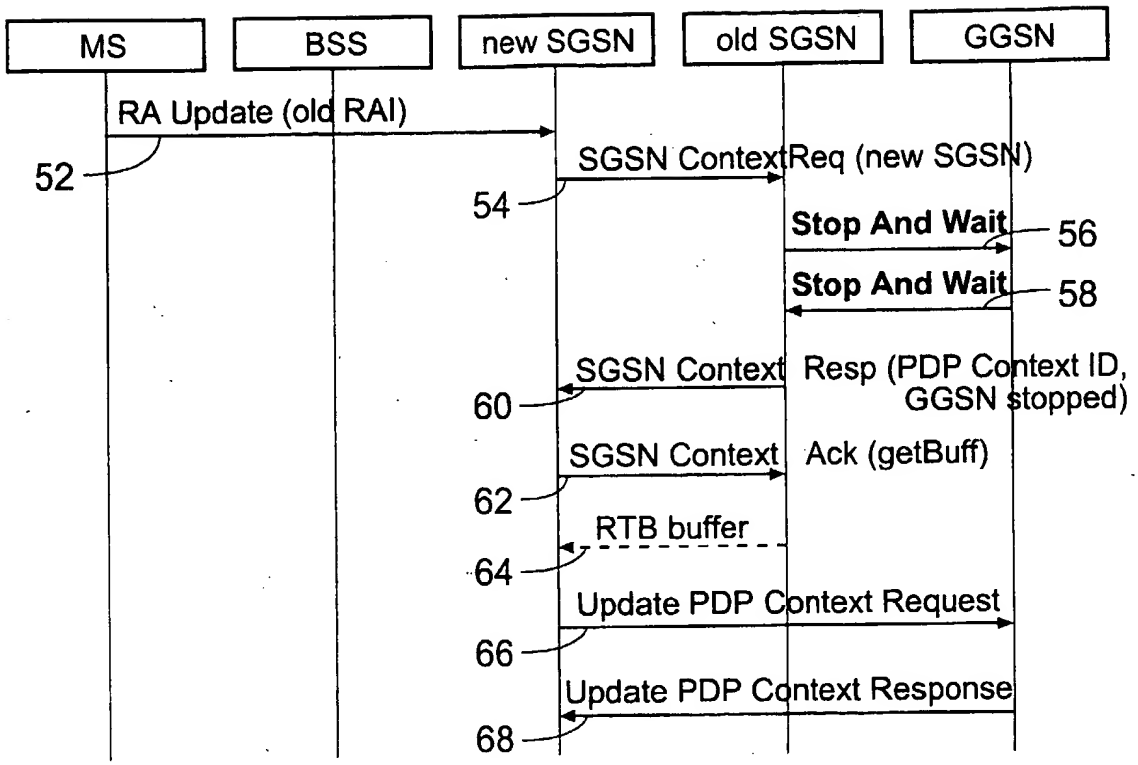
MS
BSS
new SGSN
old SGSN
GGSN
RA Update (old RAI)
52
SGSN ContextReq (new SGSN)
54
Stop And Wait
56
Stop And Wait
58
SGSN Context Resp (PDP Context ID, GGSN stopped)
60
SGSN Context Ack (getBuff)
62
RTB buffer
64
Update PDP Context Request
66
Update PDP Context Response
68

Fig. 4

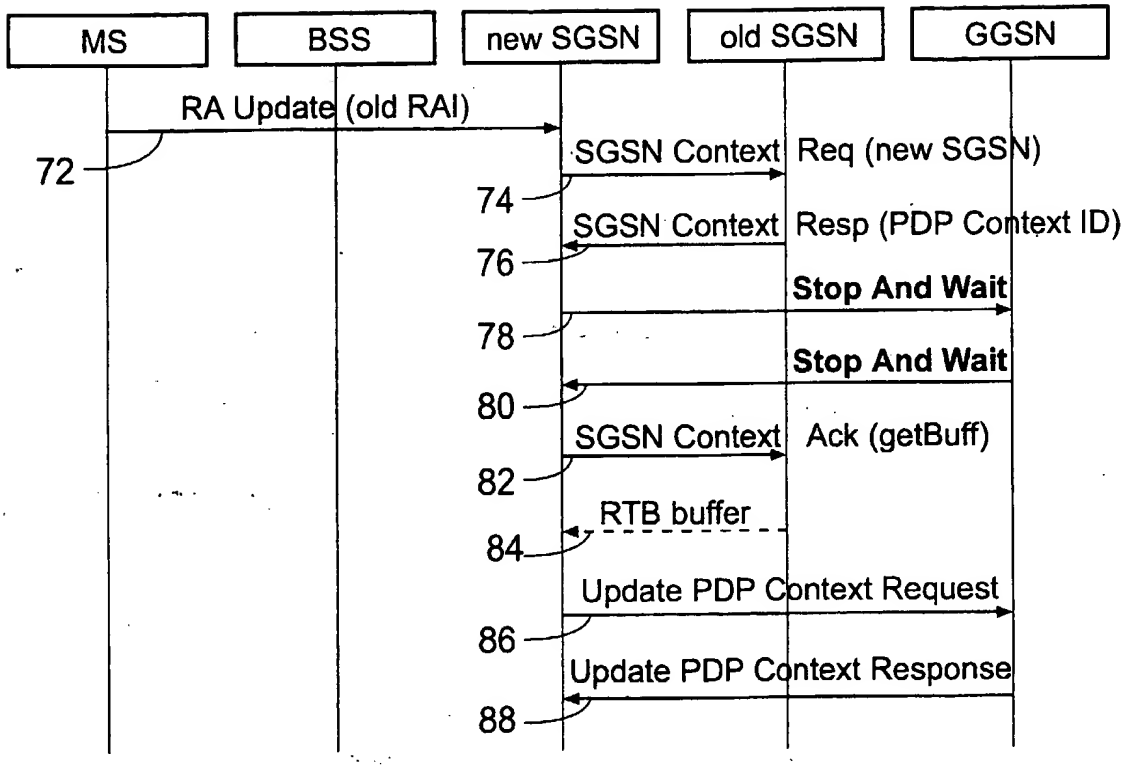
MS
BSS
new SGSN
old SGSN
GGSN
RA Update (old RAI)
72
SGSN Context Req (new SGSN)
74
SGSN Context Resp (PDP Context ID)
76
Stop And Wait
78
Stop And Wait
80
SGSN Context Ack (getBuff)
82
RTB buffer
84
Update PDP Context Request
86
Update PDP Context Response
88

Fig. 5

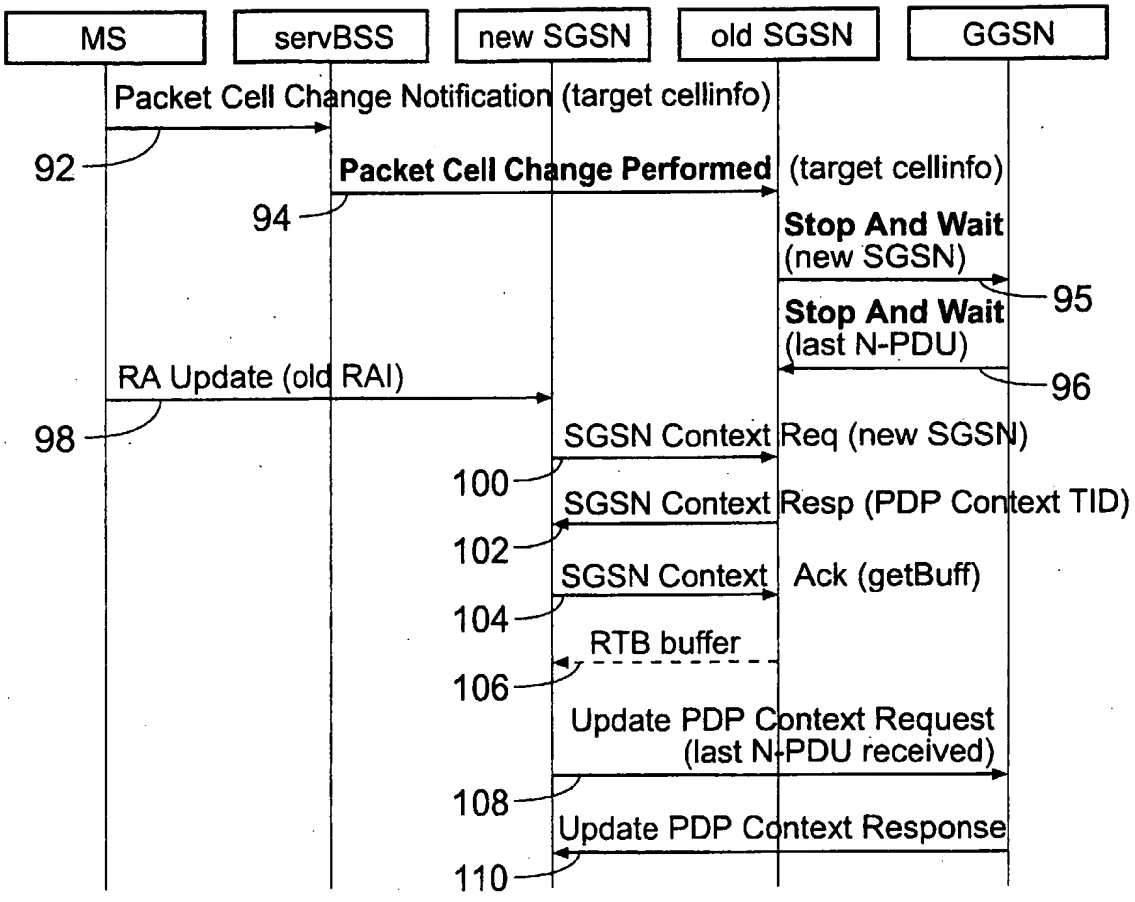
MS
servBSS
new SGSN
old SGSN
GGSN
Packet Cell Change Notification (target cellinfo)
92
Packet Cell Change Performed (target cellinfo)
94
Stop And Wait (new SGSN)
95
Stop And Wait (last N-PDU)
96
RA Update (old RAI)
98
SGSN Context Req (new SGSN)
100
SGSN Context Resp (PDP Context TID)
102
SGSN Context Ack (getBuff)
104
RTB buffer
106
Update PDP Context Request (last N-PDU received)
108
Update PDP Context Response
110

Fig. 6

MOBILE COMMUNICATION SYSTEM

TECHNICAL FIELD OF THE INVENTION

This invention relates to a mobile communications network, and in particular to a procedure to be followed when a mobile device changes a network node with which it is associated.

BACKGROUND OF THE INVENTION

In a General Packet Radio Service (GPRS) mobile radio communication network, the network architecture includes at least one Gateway GPRS Support Node (GGSN), to which are connected a variety of Serving GPRS Support Nodes (SGSN), which are each responsible for mobile stations within their respective routeing areas.

The GPRS standard, GSM 03.60 version 7.4.0 describes at section 6.9.1.2.2 an Inter SGSN Routeing Area Update procedure, to be followed when a mobile station requests allocation to a new SGSN. This procedure may be initiated while a stream of data packets is being sent from the GGSN to the mobile station. Therefore, the procedure must be able to ensure that the data packets are correctly delivered to the mobile station.

Thus, according to the prior art procedure, when a mobile station wishes to change from a cell served by a first SGSN (the old SGSN) to a cell served by a second SGSN (the new SGSN), the mobile station sends a routeing area update request to the new SGSN, which contacts the old SGSN. At that time, the old SGSN starts a timer, and stops transmission of further Protocol Data Units (N-PDUs) to the mobile station.

The new SGSN informs the GGSN of the change of

SGSN.

Meanwhile, the old SGSN sends to the new SGSN any N-PDUs that have been sent to the mobile station in acknowledged mode but have not yet been acknowledged, together with any N-PDUs that have been received from the GGSN but have not been converted into Logical Link Control (LLC) frames for transmission to the mobile station. The old SGSN also sends to the new SGSN any additional N-PDUs which are received from the GGSN before the expiry of the timer mentioned above.

The new SGSN must therefore receive these N-PDUs from the old SGSN, at the same time as it is receiving N-PDUs from the GGSN. These N-PDUs must be re-ordered, so that the data can be sent to the mobile station in the correct order. This can be especially problematic in the case of two handovers which follow quickly on from each other. Moreover, it is difficult to set an appropriate value for the timer, which is long enough to ensure that all necessary N-PDUs are forwarded from the old SGSN to the new SGSN, but a the same time is short enough to ensure that the old SGSN does not remain blocked for longer than necessary.

SUMMARY OF THE INVENTION

According to the present invention, there is provided an SGSN handover procedure, which reduces the need for resequencing in the SGSN.

According to a preferred aspect of the present invention, this is achieved in that a message is sent to the GGSN, requesting that it stop transmission of N-PDUs. At that time, the old SGSN transfers to the new SGSN any N-PDUs which it needs to transmit to the mobile station. The GGSN resumes transmission of N-PDUs, this time to the new SGSN, when the handover is

complete.

This reduces the requirement for the new SGSN to resequence the received N-PDUs.

In one embodiment of the present invention, the signal to the GGSN, requesting it to stop transmission, is sent from the old SGSN when the old SGSN receives a message from the new SGSN, informing it that the mobile station has moved to a cell served by the new SGSN.

According to a second embodiment of the present invention, the message to the GGSN, requesting it to stop transmission, is sent from the old SGSN on receipt by the old SGSN of a message from the serving base station, informing it that the mobile station has changed to a cell served by another SGSN.

According to a third embodiment of the present invention, the message to the GGSN, requesting it to stop transmission, is sent from the new SGSN on receipt of a Routeing Area Update.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematic representation of a part of a mobile communications network in accordance with the present invention.

Figure 2 is a schematic representation illustrating the general principle behind the present invention.

Figure 3 shows the update procedure according to one embodiment of the present invention.

Figure 4 shows the update procedure according to a second embodiment of the present invention.

Figure 5 shows the update procedure according to a third embodiment of the present invention.

Figure 6 shows the update procedure according to a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1 is a schematic diagram illustrating the relationship between the component parts of a General Packet Radio Service (GPRS) mobile radio communications network. It will be appreciated that Figure 1 shows only a small fraction of the components in a typical network. The network includes a plurality of Gateway GPRS Support Nodes (GGSNs) each of which is connected to a digital wired telecommunications network (ISDN). Each of the GGSNs is in communication with one or more Serving GPRS Support Nodes (SGSNs), each of which is in turn in communication with one or more base stations (BSs).

Each base station serves the mobile stations (MSs) in a specific geographic coverage area.

Communications between the mobile station and the respective base station take place over the air interface.

The Logical Link Control (LLC) transport protocol is used to transport all signalling and application data between the relevant SGSN and a mobile station.

Figure 2 is a schematic illustration showing the principle of the present invention. Specifically, when a mobile station moves from a geographical area served by a first SGSN (the "old SGSN") to a geographical area served by a second SGSN (the "new SGSN"), a notification is sent, namely a Packet Cell Change Notification to the old SGSN (message A1 in Figure 2), and/or a Routeing Area Update Request to the new SGSN (message A2 in Figure 2).

From this time, the old SGSN sends no further data to the mobile station, but a message (message B) is sent to the GGSN, either from the old SGSN or the new SGSN instructing the GGSN to cease transmission of N-

PDU data packets to the old SGSN.

There is then communication between the two SGSNs involved in the handover (messages C and D in Figure 2), as a result of which the data packets in the transmission buffer (TB) of the old SGSN, that is the data packets which have not yet been sent to the mobile station, and the data packets in the retransmission buffer (RTB) of the old SGSN, that is the data packets which have been sent to the mobile station but not yet acknowledged, are sent from the old SGSN to the new SGSN.

The buffered data packets which are transmitted to the new SGSN can then be transmitted or retransmitted as required.

When the handover is complete, the new SGSN sends a message (message E) to the GGSN, requesting it to update the PDP context. From then on, the GGSN can begin transmitting data packets for the mobile station to the new SGSN.

Figure 3 is a more detailed diagram, showing one possible implementation of a procedure operating on the principles illustrated in Figure 2. It will be appreciated that the procedure described herein is similar in some respects to that described in the GPRS standard, GSM 03.60 version 7.4.0 at section 6.9.1.2.2. It is assumed that messages in the illustrated procedure, which perform the same functions as messages contained in the prior art procedure, do not need to be described fully.

Thus, in step 32, when a mobile station in packet idle mode performs a cell reselection, and in the new cell determines that the new cell belongs to a new routing area, it sends a Routeing Area (RA) Update Request to the new SGSN, indicating the old Routeing Area Identity (RAI).

As in the prior art procedure, the new SGSN then sends at step 34 a SGSN Context Request message to the old SGSN, and the old SGSN sends at step 36 a SGSN Context Response message, which amongst other things contains a list of active Packet Data Protocol (PDP) contexts associated with the mobile station.

On receipt of the SGSN Context Response message, the new SGSN performs any required security functions (not shown in Figure 3) with the mobile station, and starts a timer, which runs for a preset time.

In accordance with the invention, in step 37, the old SGSN at this point sends a Stop And Wait message to the GGSN, requesting that it stop transmission of N-PDUs to it while awaiting handover to a new SGSN. The Stop And Wait message indicates the address of the new SGSN, the identity (P-IMSI) of the mobile station, the list of active contexts (Context ID) of the mobile station, and the GPRS Tunnelling Protocol (GTP) Tunnel Identifier (TID).

In step 38, the GGSN sends to the old SGSN a Stop And Wait Acknowledge message, indicating that no more N-PDUs will be sent to the old SGSN. This message also indicates the sequence number of the last N-PDU. Alternatively, or additionally, the last N-PDU sent from the GGSN to the old SGSN can indicate in the header information that it is the end of the transmission.

In step 39, the old SGSN sends a GGSN Stopped message to the new SGSN, confirming that the GGSN will send no more N-PDUs to the old SGSN.

In step 40, after completing the security functions with the mobile station, the new SGSN sends an SGSN Context Acknowledged message to the old SGSN, and this message also indicates that the new SGSN is now ready to receive buffered data. The SGSN Context

Acknowledged message can be sent either in response to the GGSN Stopped message, or on expiry of the preset time since the starting of the timer mentioned above.

The old SGSN will have buffered data which has already been transmitted to the mobile station but has not been acknowledged, and data which has been received from the GGSN but has not yet been transmitted to the mobile station. The old SGSN is responsible for calculating the routing data and the N-PDU sequence numbering for all such data. In step 42, this buffered data from the transmission buffer and the retransmission buffer is sent via the GTP protocol on the Gn interface from the old SGSN to the new SGSN. The latest buffered N-PDU is preferably identified as such.

Assuming that the routing area update procedure can be completed, in step 44 the new SGSN sends an Update PDP Context Request message to the GGSN. The Update PDP Context Request message indicates that traffic to the new SGSN can begin (TrafOn), and also indicates the identity (P-IMSI) of the mobile station and the list of active contexts (Context ID) of the mobile station.

In response, in step 46, the GGSN sends an Update PDP Context Response message to the new SGSN. At that point, the GGSN can recommence transmitting N-PDUs for the mobile station, and begins sending them to the new SGSN.

Figure 4 illustrates an alternative procedure in accordance with the invention. In step 52, when a mobile station in packet idle mode performs a cell reselection, and in the new cell determines that the new cell belongs to a new routing area, it sends a Routeing Area (RA) Update Request to the new SGSN, indicating the old Routeing Area Identity (RAI).

As in the prior art procedure, the new SGSN then sends at step 54 a SGSN Context Request message to the old SGSN.

In accordance with the invention, in step 56, the old SGSN at this point sends a Stop And Wait message to the GGSN, requesting that it stop transmission of N-PDUs to it while awaiting handover to a new SGSN. The Stop And Wait message indicates the address of the new SGSN, the identity (P-IMSI) of the mobile station, the list of active contexts (Context ID) of the mobile station, and the GPRS Tunnelling Protocol (GTP) Tunnel Identifier (TID).

In step 58, the GGSN sends to the old SGSN a Stop And Wait Acknowledge message, indicating that no more N-PDUs will be sent to the old SGSN. This message also indicates the sequence number of the last N-PDU. Alternatively, or additionally, the last N-PDU sent from the GGSN to the old SGSN can indicate in the header information that it is the end of the transmission.

On receipt of the Stop And Wait Acknowledge message, the old SGSN sends at step 60 a SGSN Context Response message, which amongst other things contains a list of active Packet Data Protocol (PDP) contexts associated with the mobile station. The SGSN Context Response message also confirms to the new SGSN that the GGSN is stopped, and will send no more N-PDUs to the old SGSN.

In step 62, after completing security functions with the mobile station, the new SGSN sends an SGSN Context Acknowledged message to the old SGSN, and this message also indicates that the new SGSN is now ready to receive buffered data.

The old SGSN will have buffered data which has already been transmitted to the mobile station but has

not been acknowledged, and data which has been received from the GGSN but has not yet been transmitted to the mobile station. The old SGSN is responsible for calculating the routing data and the N-PDU sequence numbering for all such data. In step 64, this buffered data from the transmission buffer and the retransmission buffer is sent via the GTP protocol on the Gn interface from the old SGSN to the new SGSN. The latest buffered N-PDU is preferably identified as such.

Assuming that the routing area update procedure can be completed, in step 66 the new SGSN sends an Update PDP Context Request message to the GGSN. The Update PDP Context Request message indicates that traffic to the new SGSN can begin (TrafOn), and also indicates the identity (P-IMSI) of the mobile station and the list of active contexts (Context ID) of the mobile station.

In response, in step 68, the GGSN sends an Update PDP Context Response message to the new SGSN. At that point, the GGSN can recommence transmitting N-PDUs for the mobile station, and begins sending them to the new SGSN.

Figure 5 shows a further alternative procedure in accordance with the invention. In step 72, when a mobile station in packet idle mode performs a cell reselection, and in the new cell determines that the new cell belongs to a new routing area, it sends a Routeing Area (RA) Update Request to the new SGSN, indicating the old Routeing Area Identity (RAI).

As in the prior art procedure, the new SGSN then sends at step 74 a SGSN Context Request message to the old SGSN, and the old SGSN sends at step 76 a SGSN Context Response message, which amongst other things contains a list of active Packet Data Protocol (PDP)

contexts associated with the mobile station.

On receipt of the SGSN Context Response message, at step 78, the new SGSN sends a Stop And Wait message to the GGSN, requesting that it stop transmission of N-PDUs to the old SGSN. The Stop And Wait message indicates the address of the new SGSN, the identity (P-IMSI) of the mobile station, the list of active contexts (Context ID) of the mobile station, and the GPRS Tunnelling Protocol (GTP) Tunnel Identifier (TID).

In step 80, the GGSN sends to the new SGSN a Stop And Wait Acknowledge message, indicating that no more N-PDUs will be sent to the old SGSN. This message also indicates the sequence number of the last N-PDU sent from the GGSN to the old SGSN.

In step 82, the new SGSN sends an SGSN Context Acknowledged message to the old SGSN, and this message also indicates that the new SGSN is now ready to receive buffered data.

The old SGSN will have buffered data which has already been transmitted to the mobile station but has not been acknowledged, and data which has been received from the GGSN but has not yet been transmitted to the mobile station. The old SGSN is responsible for calculating the routing data and the N-PDU sequence numbering for all such data. In step 84, this buffered data from the transmission buffer and the retransmission buffer is sent via the GTP protocol on the Gn interface from the old SGSN to the new SGSN. The latest buffered N-PDU is preferably identified as such.

Assuming that the routing area update procedure can be completed, in step 86 the new SGSN sends an Update PDP Context Request message to the GGSN. The Update PDP Context Request message indicates that traffic to the new SGSN can begin (TrafOn), and also

indicates the identity (P-IMSI) of the mobile station and the list of active contexts (Context ID) of the mobile station.

In response, in step 88, the GGSN sends an Update PDP Context Response message to the new SGSN. At that point, the GGSN can recommence transmitting N-PDUs for the mobile station, and begins sending them to the new SGSN.

Figure 6 shows a further alternative procedure in accordance with the invention. In step 92, when a mobile station in packet idle mode performs a cell reselection, it sends a Packet Cell Change Notification message to its serving base station, indicating the identity of the target cell.

If the request is accepted by the network, the base station sends a Packet Cell Change Order (not shown) to the mobile station, with an indication of the target cell. If the target cell is served by a different SGSN, then, in parallel with the Packet Cell Change Order, the serving base station sends a Packet Cell Change Performed message, step 94, to the old SGSN, also with an indication of the target cell and the mobile station identity (IMSI).

In accordance with the invention, in step 95, the old SGSN at this point sends a Stop And Wait message to the GGSN, requesting that it stop transmission of N-PDUs to it while awaiting handover to a new SGSN. The Stop And Wait message indicates the address of the new SGSN, the identity (P-IMSI) of the mobile station, the list of active contexts (Context ID) of the mobile station, and the GPRS Tunnelling Protocol (GTP) Tunnel Identifier (TID).

In step 96, the GGSN sends to the old SGSN a Stop And Wait Acknowledge message, indicating that no more N-PDUs will be sent to the old SGSN. This message also

indicates the sequence number of the last N-PDU. Alternatively, or additionally, the last N-PDU sent from the GGSN to the old SGSN can indicate in the header information that it is the end of the transmission.

In step 98 meanwhile, in parallel with the Stop And Wait messages, if the mobile station in the new cell determines that the new cell belongs to a new routing area, it sends a Routeing Area (RA) Update Request to the new SGSN, indicating the old Routeing Area Identity (RAI).

The new SGSN then sends at step 100 a SGSN Context Request message to the old SGSN, and the old SGSN sends at step 102 a SGSN Context Response message, which amongst other things contains a list of active Packet Data Protocol (PDP) contexts associated with the mobile station.

In step 104, the new SGSN sends an SGSN Context Acknowledged message to the old SGSN, and this message also indicates that the new SGSN is now ready to receive buffered data.

The old SGSN will have buffered data which has already been transmitted to the mobile station but has not been acknowledged, and data which has been received from the GGSN but has not yet been transmitted to the mobile station. The old SGSN is responsible for calculating the routing data and the N-PDU sequence numbering for all such data. In step 106, this buffered data from the transmission buffer and the retransmission buffer is sent via the GTP protocol on the Gn interface from the old SGSN to the new SGSN. The latest buffered N-PDU is preferably identified as such.

Assuming that the routing area update procedure can be completed, in step 108 the new SGSN sends an

Update PDP Context Request message to the GGSN. The Update PDP Context Request message indicates that traffic to the new SGSN can begin (TrafOn), and also indicates the identity (P-IMSI) of the mobile station and the list of active contexts (Context ID) of the mobile station.

In response, in step 110, the GGSN sends an Update PDP Context Response message to the new SGSN. At that point, the GGSN can recommence transmitting N-PDUs for the mobile station, and begins sending them to the new SGSN.

The new SGSN is therefore able to send data to the mobile station with the minimum of delay, and with a minimum requirement for resequencing of data in the new SGSN.

There are therefore described procedures which allow an inter-SGSN to be performed, while minimising the need for re-sequencing of data in the new SGSN, and hence improving the performance for the mobile station.

It will be appreciated that, although the invention has been described with reference to its use in a GPRS network, it is not limited to such application.

CLAIMS

1. An inter-SGSN handover method, for use in a GPRS network comprising at least one Gateway GPRS Support Node (GGSN) and a plurality of Serving GPRS Support Nodes (SGSNs) connected thereto, when a mobile station is to be handed over from a first SGSN to a second SGSN, the method comprising:

sending a Stop and Wait message to the GGSN;

on receipt by the GGSN of the Stop and Wait message, suspending transmission of data to said mobile station;

transmitting buffered data from the first SGSN to the second SGSN;

transmitting the buffered data from the second SGSN to the mobile station; and

on completion of the inter-SGSN handover procedure, resuming transmission of data from the GGSN to the mobile station, via the second SGSN.

2. A method as claimed in claim 1, wherein the buffered data comprises data sent from the first SGSN to the mobile station but not yet acknowledged.

3. A method as claimed in claim 1 or 2, wherein the buffered data comprises data sent from the GGSN to the first SGSN but not yet sent to the mobile station.

4. A method as claimed in claim 1, wherein the Stop and Wait message is sent to the GGSN from the first SGSN.

5. A method as claimed in claim 4, wherein the Stop and Wait message is sent from the first SGSN to the GGSN on receipt by the first SGSN of a message from the base station currently serving the mobile station.

6. A method as claimed in claim 5, wherein the Stop and Wait message is sent from the first SGSN to the GGSN on receipt by the first SGSN of a Packet Cell Change Performed message from the base station

currently serving the mobile station.

7. A method as claimed in claim 4, wherein the Stop and Wait message is sent from the first SGSN to the GGSN on receipt by the first SGSN of a message from the second SGSN.

8. A method as claimed in claim 7, wherein the Stop and Wait message is sent from the first SGSN to the GGSN on receipt by the first SGSN of a SGSN Context Request message from the second SGSN.

9. A method as claimed in claim 8, wherein the first SGSN sends a SGSN Context Response message to the second SGSN, and a separate message confirming that the GGSN has suspended transmission of data.

10. A method as claimed in claim 8, wherein the first SGSN sends a SGSN Context Response message to the second SGSN, including confirmation that the GGSN has suspended transmission of data.

11. A method as claimed in claim 1, wherein the Stop and Wait message is sent to the GGSN from the second SGSN.

12. A method as claimed in claim 11, wherein the Stop and Wait message is sent from the second SGSN to the GGSN after the second SGSN has sent a SGSN Context Request message to the first SGSN, and received a SGSN Context Response message from the second SGSN.

13. A Serving GPRS Support Node (SGSN), for use in a GPRS network comprising at least one Gateway GPRS Support Node (GGSN) and a plurality of SGSNs connected thereto,

wherein the SGSN, on receipt of a message indicating that a mobile station is to be handed over therefrom to a second SGSN:

sends a Stop and Wait message to the GGSN, requesting that it send no more data for said mobile station; and

transmits buffered data to the second SGSN.

14. An SGSN as claimed in claim 13, wherein the buffered data comprises data sent from the SGSN to the mobile station but not yet acknowledged.

15. An SGSN as claimed in claim 13 or 14, wherein the buffered data comprises data sent from the GGSN to the SGSN but not yet sent to the mobile station.

16. An SGSN as claimed in claim 13, wherein the SGSN sends the Stop and Wait message to the GGSN on receipt by the SGSN of a message from the base station currently serving the mobile station.

17. An SGSN as claimed in claim 13, wherein the SGSN transmits the buffered data to the second SGSN on receipt of an SGSN Context Acknowledgement message from said second SGSN.

18. An SGSN as claimed in claim 13, wherein the Stop and Wait message is sent from the SGSN to the GGSN on receipt by the SGSN of a message from the second SGSN.

19. A Gateway GPRS Support Node (GGSN), for use in a GPRS network comprising at least one GGSN and a plurality of Serving GPRS Support Nodes (SGSNs) connected thereto, the GGSN:

on receipt of a Stop and Wait message from a first SGSN, suspending transmission of data to a mobile station; and

on completion of an inter-SGSN handover from the first SGSN to a second SGSN, resuming transmission of data to the mobile station, via the second SGSN.

20. A GGSN as claimed in claim 19, wherein the GGSN resumes transmission of data via the second SGSN, on receipt of an Update PDP Context Request therefrom.

21. A base station, for use in a GPRS network comprising a plurality of Serving GPRS Support Nodes

(SGSNs), the base station being connected to a first SGSN, wherein

when a mobile station is to be handed over from said base station to a second base station which is connected to a second SGSN, the base station sends a message to the first SGSN identifying the second base station.

22. In a mobile communications network, comprising at least one node at a first upper level, a plurality of nodes at a second intermediate level and a plurality of nodes at a third lower level, wherein each of the nodes at the third level is connected to a node at the second level, and each of the nodes at the second level is connected to a node at the first level, and wherein each of the nodes at the third level serves mobile stations generally within a respective geographical coverage area, a method of handing over a mobile station from a first node at the third level to a second node at the third level, when the first node at the third level is connected to a first node at the second level and the second node at the third level is connected to a second node at the second level, the method comprising:

on receipt by one of the nodes at the second level of a message indicating that the mobile station is to be handed over from the first node at the second level to the second node at the second level, sending a Stop and Wait message to the node at the first level;

on receipt by the node at the first level of the Stop and Wait message, suspending transmission of data to said mobile station;

transmitting buffered data from the first node at the second level to the second node at the second level;

transmitting the buffered data from the second

node at the second level to the mobile station; and

on completion of the handover, resuming transmission of data from the node at the first level to the mobile station, via the second node at the second level.

INVESTOR IN PEOPLE

Application No: GB 0109371.5 **Examiner:** Jared Stokes
Claims searched: 1 to 20, 22 **Date of search:** 16 January 2002

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H4L (LDGP, LRPMS, LRPMW)

Int Cl (Ed.7): H04Q (7/38)

Other: On-Line - EPODOC, INSPEC, JAPIO, WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WO 00/79808 A2 (Ericsson) See page 2 line 22-page 3 line 5, page 20 lines 14-17, page 21 line 19-page 22 line 15	-
X	WO 00/32001 A2 (Nokia) See page 8 line 6-page 10 line 9	1,3,13,19, 22
A	WO 99/34635 A2 (Ericsson) See abstract	-

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.